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Escola de Engenharia

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**Ergonomic assessment of the activities  
developed by the canteen professionals of  
a Portuguese university: study of the main  
WMSD risk factors**

Master Dissertation

Master in Human Engineering

Work done under the academic supervision of

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## **ACKNOWLEDGMENTS**

Thank God first for allowing me to reach another goal in my life.

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To Professor Paula for always being so cordial and kind from the first day this master began.

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## **ABSTRACT**

Work-related musculoskeletal disorders (WMSD) are currently one of the main causes of absenteeism related to health problems.

Taking into account that the work was carried out in an industrial kitchen, where different types of activities are performed, this study aims to identify and characterize the activities to evaluate the ergonomic risks to which the employees are exposed. Those risks are associated to postures, repetitive movements, manual handling of loads, among others. The analysis allows giving recommendations to reduce the risk of musculoskeletal disorders.

The main methodologies used were a questionnaire based on the Nordic questionnaire, videos, direct interviews with the employees, which allowed to choose the main activities in which there were flaws in the ergonomic factors. The Rapid Entire method Body Assessment (REBA) was used for the evaluation for those activities in which there were repetitive movements, incorrect postures, whereas the Key Indicator Method (KIM) was used for the activities involving manual handling of loads.

Twenty-three workers were evaluated obtaining the body regions with the highest percentage of musculoskeletal complaints in the last 12 months: the lumbar area with 83%, 74% feet, and 74% neck; these body areas coinciding with absenteeism in the last 12 months with 57% lumbar, 48% feet and 43% neck. An average was obtained for the pain scale, ranging from 0 (without pain) to 10 points (maximum pain), giving 7 points for the lower back and 6 points for both the feet and neck.

Six activities were evaluated with the KIM method and the results show that five activities obtained a medium-risk level and the sixth activity a high-risk level in terms of classification. It was concluded that the typical activities of the canteen can generate musculoskeletal disorders in workers, for which a series of recommendations are given.

**KEYWORDS:** Canteens, Ergonomics, Industrial kitchen, KIM, Musculoskeletal disorders, REBA.

## RESUMO

As lesões musculoesqueléticas relacionadas com o trabalho (LMERT) são atualmente uma das principais causas de absentismo associado a problemas de saúde.

Considerando que durante o trabalho realizado numa cozinha industrial existem diferentes tipos de atividade, este estudo tem como objetivo identificar e caracterizar as atividades desenvolvidas pelos trabalhadores de uma cantina universitária Portuguesa com o intuito de avaliar o risco de LMERT a que os trabalhadores estão expostos, devido a fatores como posturas, movimentos repetitivos, manipulação manual de cargas, entre outros. Pretende-se, ainda, dar sugestões e recomendações de alteração dessas atividades de forma a reduzir o risco de LMERT.

A metodologia de trabalho envolveu a aplicação de diversos métodos de recolha de informação, tal como um questionário, baseado no questionário nórdico de avaliação da sintomatologia musculoesquelética auto-referida, vídeos, entrevistas diretas com os funcionários, o que permitiu selecionar as atividades com maiores problemas ao nível da ergonomia. A avaliação do risco associado a estas atividades foi efetuada através do método *Rapid Entire Body Assessment* (REBA), para as atividades em que houve movimentos repetitivos, posturas inadequadas, ou alterações rápidas à postura e o *Key Indicator Method* (KIM) para as atividades que envolvem manipulação manual de cargas.

A amostra constou de 23 trabalhadores, sendo que as regiões corporais com maior prevalência de queixas musculoesqueléticas nos últimos 12 meses foram a região lombar (83%), os pés (74%) e o pescoço (74%). Essas áreas corporais coincidem com os valores obtidos relativamente à questão “nos últimos 12 meses deixou de fazer as suas atividades devido a esses distúrbios”, com 57% (região lombar), 48% (pés) e 43% (pescoço). Da aplicação da escala de dor, variando de 0 (sem dor) a 10 pontos (dor máxima), foram obtidos valores médios para as diferentes regiões corporais: 7 pontos para a região lombar e 6 pontos para os pés e pescoço.

Seis atividades foram avaliadas com o método KIM, em cinco obteve-se um nível de risco médio e na outra atividade obteve-se um nível de risco alto. Com o método REBA, foram

avaliadas quatro atividades, numa obteve-se um nível de risco médio, em duas obteve-se um nível de risco alto e noutra um nível de risco muito alto.

Concluiu-se desta maneira que as atividades típicas da cantina podem gerar distúrbios musculoesqueléticos nos trabalhadores, para os quais foram fornecidas várias recomendações e sugestões de melhoria.

**PALAVRAS-CHAVE:** Ergonomia, Cozinha Industrial, KIM, Lesões musculoesqueléticas, REBA.

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## **LIST OF ABBREVIATIONS**

**FIFO:** First in First Out

**KIM:** Key Indicator Method

**REBA:** Rapid entire body assessment

**WMSD:** Work-related musculoskeletal disorders

**SD:** Standard deviation





# 1. INTRODUCTION

## 1.1 Theoretical framework

Nowadays, the evaluation of occupational risks is recognized as the basis for active management for the safety and health of work, aiming to avoid or reduce accidents or diseases in the workplace. In 2015 there were more than 3.2 millions of non-fatal accidents with at least 4 days of absenteeism and it is estimated 3876 of fatal accidents in the EU, representing 830 non-fatal accidents for each fatal accident (ESAW, 2018).

Work-related Musculoskeletal Disorders (WMSD) are part of non-fatal accidents. European Agency for Occupational Safety and Health Administration at Work (EU-OSHA) (EU-OSHA) defined musculoskeletal disorders with professional origin as injuries in muscles, joints, tendons, ligaments, nerves, bones and localized diseases of the circulatory system, caused or aggravated mainly by professional activity and the effects of the immediate conditions in which the activity takes place (EU-OSHA, 2010). In general, these musculoskeletal injuries result from the repeated exposure of efforts in a prolonged time, due to physical, organizational, biomechanical, individual, and personal factors.

Among the many factors that can determine the occurrence of WMSD, those related to work seem to be of considerable importance. Epidemiological studies indicate that between 11 to 88% of lumbar lesions and between 11 to 95% of lesions in limbs are attributed to physical factors related to the workplace (Marras et al., 2009). According to the statistical data (BLS, 2012) the musculoskeletal disorders were responsible for 33% of all injuries and diseases in the workplace in 2011, with an incidence rate of 39 cases per 10,000 full-time workers.

It is very important to know how to approach or determine if an intervention is necessary in a workplace, an effective aspect to determine is to take into account reports or complaints from workers, as this can determine the main causes and provide solutions.

This work was developed in a canteen of a university where many tasks can be risky for workers, such as falls, burns, cuts, temperature, noise, lighting, repetitive movements, forced postures, etc. In this study we will focus on ergonomic factors such as repetitive movements, incorrect postures, load handling.

A process of ergonomic intervention in 59 kitchens in Finland managed to implement 402 ergonomic changes, after taking as a starting point the latest 3 months reports of the workers, in which 87% reported pain in some part of the musculoskeletal system (Pehkonen, Takala, Ketola, and Viikari-Juntura, 2009).

Foodservice establishments employ a large number of workers of all ages who are exposed to many work-related hazards, which can cause injury or illness, and the causes of musculoskeletal injuries are a combination of workplace, work, and worker. Repetitive movements are mainly harmful if they involve the same joints and group of muscles, the greater the repetitions the greater the risk of injury. In the kitchens, these repetitive works made by postures of arms and hands and trunk rotation are very common in many tasks such as cooking, preparing food, washing dishes, cleaning, lifting and handling heavy pots, mixing of large quantities of food, among others. In a study of 90 kitchen workers corresponding to 3 different locations, it was found that 19% of the sample reported work-related injuries on the forearm and shoulder due to repetitive movements (Bindu & Reddy, 2016).

In another study that procure to compare the results of a questionnaire and surveys in the workplace for determining if there is a real connection between the opinions of the employees and the conditions of the work, the employees were asked about the diseases and symptoms in the musculoskeletal system, the questionnaire revealed that 30% of the respondents had medically confirmed diseases of the musculoskeletal system and the most frequent locations were the shoulders (76%), the neck and occipital region (58%), and the lumbar region (59%) (Pekkarinen, Anttonen, & Niskanen, 1996).

According to analysis of risks made previously in the canteen of the University, there is a high level of risk related to uncomfortable postures, repetitive movements or excessive efforts, even in some cases the impediment to perform daily life activities is high, as is show in the Annex 1.

According to the above mentioned, it is important to know if there is a relation between the typical activities of the canteen and the risk of musculoskeletal injury.

## **1.2 Objectives**

The main objective of this work is to identify the main WMSD risk factors in the workers of a Portuguese university canteen for the implementation of measures that allow lowering this type of risk. As specific objectives:

- Identify and characterize activities;
- Assess the risk related to ergonomic factors: postures, repetitive movements, load manipulation.
- Make suggestions for improving work processes, always focusing on the health and welfare of the worker, reducing the occurrence of musculoskeletal disorders.

## **1.3 Thesis structure**

This work is divided into 5 chapters. This first chapter provides an introduction of the subject to study and defines the objectives.

In the second chapter a bibliographic review is made referring to topics of interest such as: ergonomics, musculoskeletal injuries, risk factors for musculoskeletal injuries, manual movements of loads, REBA and KIM risk assessment methods.

Chapter 3 deals with the methodology in which the methods of analysis are explained, the sample size and the tools used are indicated, the activities carried out in the workplace are described and the methods for assessing musculoskeletal risks are established.

In Chapter 4, all the results obtained throughout the study are presented, as well as its discussion, recommendations and suggestions.

Finally, the conclusions are presented in chapter 5.

## **2. BIBLIOGRAPHIC REVIEW**

### **2.1 Ergonomics**

Ergonomics study the relation between the human factor and the work accomplished, considering the integration between the workplace conditions, worker capacity, and productivity. It is a science that is responsible for improving the workplace to minimize risks and avoid injuries, creating a safe, comfortable and productive place throw some aspects, like the right tools design and workplace design based on anthropometric measures taking into account the strength, ability, and sensorial capacity (IEA,2000).

According to APSEI (2019), Ergonomics is the application of scientific knowledge in the objects design, systems, and technology used for human beings with the aim to guarantee the health and safety of employees and increase productivity levels.

Ergonomics has two objectives: a social objective related to the welfare of workers and an economic objective related to the system performance, taking into account physics and psychology aspects of employees to get benefits in terms of production (Neumann, 2005).

In short, the objectives of ergonomics are the safety, efficiency of the man-machine-environment system, and satisfaction. To achieve it, one should combine equipment, tools, and workplace with the human characteristics.

According to Miranda (2015), ergonomics has an important role in the presence of musculoskeletal injuries related to work. Carrying an interaction between the employee and the workplace, can be a way to increase the productivity and at the same time decrease the risk of injuries and discomfort of employees.

The purpose of ergonomics is to adapt working conditions to the capacity of the worker and the efficiency of the worker should not serve as justification to maintain poor working conditions or a work environment (Luttmann, Jager, & Griefahn, 2004).

According to APSEI (2019), in the work context, there are four central concerns for ergonomics, which are: safety, health, efficiency, and productivity.

Ergonomics contributes to the hygiene and safety at work avoiding:

- Absence of workers for health reasons;
- Work accidents;

- Need for professional relocation due to physical exhaustion.

Ignoring the application of ergonomic principles at work can have very serious consequences, not only for the damage caused to workers. The organization itself can suffer at the level of productivity and motivation of employees. There are many serious workplace accidents that can be avoided when ergonomic principles are applied.

To apply ergonomic principles effectively there are several aspects to consider, some of them are:

- The task to be performed and the demands of it;
- The equipment used (size, shape, adaptability);
- The information used (as presented, accessed and modified);
- The environment where the task is performed (temperature, humidity levels, lighting, noise, vibrations);
- Social environment (teamwork, administration support).

## **2.2 Work-related musculoskeletal disorders (WMSD)**

Work-related musculoskeletal disorders result, or are aggravated, from work activity. According to Barr, Barbe & Clark (2004), WMSD include inflammatory and degenerative diseases of the motor system. These result as a consequence of occupational risk factors, such as repetitiveness, overload and/or incorrect postures during work.

Some symptoms are localized pains, sensation of tingling in the affected part or near, sensation of weight, fatigue or loss of strength. Usually these symptoms arise gradually and worsen at the end of the workday or during production peaks and are relieved in breaks, resting periods or holidays.

According to Collins et al., (2011), regardless of the type of work, during a large part of the time the working population is engaged in repetitive movements and maintaining postures for long periods of time, many of these conditions occur at the interface between workers and machines. The parts of the body that are most affected are the lower back, neck, shoulders and upper extremities.

According to Luttmann, Jager, & Griefahn (2004), there are two types of injuries: acute and chronic. The acute injures are painful, caused by an intense and brief effort, which causes a

structural and functional failure, for example, tearing of the muscle by lifting a lot of weight, bone fracture, blockage of a vertebral joint by default of a sudden movement. The chronic and lasting injuries, consequence of a permanent effort and they produce pain and an increasing dysfunction, for example, tearing of ligaments by repetitive efforts, tendinitis, muscular spasm.

In general, the worker ignores this type of injuries caused by repetitive movements, since they heal quickly and do not cause an appreciable disorder.

According to Collins et al., (2011), non-specific lumbar pain is one of the most common and costly disorders that affects working people. It is estimated that it affects 15-44% of the general population in one year and more than 10% of those who suffer from this low back pain experience symptoms that persist for more than 1 year.

Some factors that contribute to lower back pain are the high body mass index, sedentary lifestyle, static postures, frequent flexions and/or torsions, as well as vibrations.

According to Luttmann, Jager, & Griefahn (2004), in industrialized countries, around one-third of sick leaves due to health reasons, are due to ailments in the locomotor system. Lumbar pain, sciatica, disc degeneration and hernias are the most frequent with approximately 60%, secondly pain in the cervical and upper extremities.

The conditions and intensity of work are important factors in the appearance and persistence of these ailments.

Eurofound (2017) referred that the biggest reported health problem is back pain with 43%, followed by muscle pains in the neck or upper limbs 42% and muscle pains in the hip and lower limbs 29%. The health problems reported vary according to the occupation, almost all health problems are strongly associated with the physical and social environment.

According to EU-OSHA (2007) the odds of a musculoskeletal disorder of occupational origin that causes loss of work-days is three times higher without ergonomic intervention than when produced such intervention.

According to Sousa, Carnide, Serranheria, Cunha, & Lopes (2008) some examples of most common musculoskeletal injuries (WMSD) are:

**1.- Rotator cup tendinitis:** it is one of the most frequent diseases in the shoulder and results from performing activities that require a sustained or repeated elevation of the upper limbs at shoulder level or above them or performing movements with the arms high.

**2.-Carpal Tunnel Syndrome:** the carpal tunnel is located in the fist, this is the injury of a peripheral nerve, caused by the compression of the median nerve in a limited space, usually the main cause is the excessive extension of the fist.

**3.-Fist tendinitis:** caused by the repetitive movements of flexion-extension of the fist and fingers, even when there are small loads or a poor posture.

**4.- Epicondylitis and Epitrocleitis:** these tendinopathies are the result of overloading the elbow by repetitive gestures or by manipulation of excessive loads or poorly distributed loads.

**5.- Rachialgia:** back pain caused by prolonged standing postures, frequent movements of flexion and extension of the spine, manipulation, and transport of loads, sitting in front of a computer for long periods of time.

European Directive 89/391 / EEC on the implementation of measures to promote the improvement of the health and safety of workers at work was published in June 1989. To this effect, this Directive includes general principles concerning the prevention of occupational risks and the protection of safety and health, the elimination of risk and accident factors, information, consultation, participation, in accordance with national laws and practices, the training of workers and their representatives, as well as general guidelines for the application of these principles (Conselho da União Europeia, 1989).

## **2.3 Risk factors for development of WMSD**

The development of musculoskeletal injuries is the result of an inappropriate environment, activity development, and poor working conditions. The presence of these risk factors indicates that the worker must be limited or exposed to it, requiring the job or workplace reevaluation in order to be in a safe and healthy environment. Three risk factors are described below (Sousa, Carnide, Serranheria, Cunha, & Lopes, 2008).

### **2.3.1 Risk factors related to work activity**

#### **1. - Extreme postures or body positions**

The posture depends on several aspects, such as biomechanical alignment; the spatial orientation of several body areas; the relative position of the various anatomical segments and the body attitude assumed during the activity of work. When one assumes a posture or position extreme, the risk of WMSD increases.



## **2. - Application of force**

Strength is a difficult concept to define, which is not equal to the effort, despite the application of force as long as the muscle works. Also the lifting of loads can be an important factor risk of injury or disease of the spine Vertebral.

It is considered a high force for upper limb, manipulation (with hands) of weights (or loads) above the 4 Kg. However, a light force applied, for example, with fingers and hand on a scissor, during the cutting of fabric easy to cut, can also cause a musculoskeletal injury related to work. The way that the force is applied is also important. The static force (constant and/or without movement) and the dynamic force (alternating and/or with movement) do not have the same risk. The static force is always more serious than dynamics.

## **3. -Repetitivity:**

Evaluate if the work is repetitive requires to know if there are cycles of work or tasks in production lines where they are used, for example, identical movements, postures or force applications with the same anatomical regions (for example, the arms and hands). The invariability of the gesture can also be a factor of risk of WMSD.

## **4. - Expose oneself to mechanical elements:**

The contact of the worker's body with other elements (for example, tools) is another risk factor, depending on the frequency, intensity, and duration of exposing.

Exposure to vibrations is also a risk factor that is often associated with the use of electric or pneumatic tools. The greater the force applied to the tool, the easier it is to transmit vibrations to the system hand-arm.

### 2.3.2 Organizational and psychosocial risk factors

These factors are conditions present in the workplace that are related to the organization, the type of work, the way to do it, which can affect the well-being and health of the employee and productivity. Some of these are:

- High productivity demands
- Stress generated by the monotony of activities
- Live and social conditions development are the basis for constituting motivation and comfortable at work sensation.

- Work schedules or shifts without, or with very short breaks and intense rhythms increase the workload and produce work incompatibility.

The psychosocial and organizational factors work in a bi-directional way, which means, if there is something on the personal life that makes feel bad, that is reflected in the work and vice versa, therefore there must be a balance.

### 2.3.3 Individual risk factors

Within the context of individual risks, age is one of them, related to the decrease in strength, aging, and mobility. Another individual factor is gender since on average women have less muscle strength. The risk associated with individual factors is often caused by age, resulting in a decrease in the tolerance of muscle tissues, strength, and joint mobility. However, older people has an advantage when compared with young people, their experience (Lopes, 2015). A supremely important individual factor is the incompatibility of height, weight or other anthropometric characteristics to which tall or small employees are exposed in jobs that are not adjustable.

## 2.4 Manual movement of loads

According to Decree-Law n° 330/93 of 25 of September, the manual movement of loads can be defined as any operation of transport and of a load, by one or more workers, that, due to their characteristics or unfavorable ergonomic conditions, represent a risk for them. The load can be animate (a person or animal) or inanimate (an object). Though decreasing lately, the rate of workers in the EU-25 that report carrying or moving heavy loads, is still high (34.5%), reaching 38.0% in the EU-10. The manual handling of loads contributes to a large percentage of the more than half a million cases of musculoskeletal disorders that are reported annually in the United States of America (EU-OSHA, 2007).

The manual manipulation of load involves movements of almost all parts of the body, for which a physical effort is necessary and depends on how heavy or not the load is, how it is handled, how much muscle fatigue can originate and even be a cause of occupational disease. In many jobs (construction, nursing homes, hospitals, package, and mail handling) heavy or frequent lifting, forceful movements, and carrying of heavy loads complicated by incorrect body posture are daily elements of required tasks. If the load is too heavy or the frequency of

lifting exceeds the tolerance, acute or chronic injuries (initially, mostly micro-traumata) to the lumbar spine can be the consequence. However, there are no simple and solid guidelines of how much weight is "too heavy" or how many lifts per hour are "too many" (Johanning, 2000).

According to Decree-Law n° 330/93, the employer shall carry out an assessment of the risk factors for the manual handling of loads and the safety and health, taking into account the characteristics of load, such as:

- Too heavy load, greater than 30 Kg for occasional operations and greater than 20 Kg for frequent operations;
- Very bulky load or difficult to grab;
- Unstable load, irregular distribution of load;
- Load placed in such a way that it must be maintained or manipulated away from the trunk or with trunk flexion or torsion.

The physical effort to which the body is subjected must also be taken into account. Some examples are the following:

- When the physical effort is excessive for the worker;
- When it should be performed by a trunk torsion movement;
- When it may involve a sudden movement of the load;
- When the task is carried out with an unstable body position.

Effective ergonomic interventions help to reduce physical stress produced by the tasks of manual handling of loads, thus reducing the severity of musculoskeletal injuries. To carry out these adjustments it is necessary to take into account: age, physical condition, strength, gender, height, among others. According to EU-OSHA (2007) the manual handling exposes workers to physical risk factors. Repetitiveness and carrying out tasks over long periods of time can cause fatigue and discomfort, over time cause injuries to the back, shoulders, hands, wrists or other parts of the body, usually musculoskeletal injuries, therefore the possible causes of these injuries are:

- Uncomfortable postures (flexion, torsion).
- Repetitive movements (reach, lift or transport consecutively).

- Transport or lift heavy loads.
- Static postures.

## **2.5 WMSD risk assessment methods**

### **2.5.1 Rapid Entire Body Assessment (REBA)**

Postural analysis is a technique to evaluate work activities, determine the risk of musculoskeletal injury through the postures adopted by the workers.

Initially, REBA was a tool designed to evaluate unpredictable work postures found in the healthcare sector, but REBA can also be used in other industrial services with this same particularity (unpredictable postures) (Hignett & McAtamney, 2000). This technique divides the body into 6 sections: trunk, neck, legs, arm, forearm, and wrist. The method has a rating system for the posture of two body segments groups (A - trunk, neck, and legs; B - arm, forearm, and wrist). The application of force/load, the type of activity (static/dynamic/repetitive), and the type of coupling are also considered. The final score combines the effect of the different risk factors, based on the different partial scores. The final REBA score corresponds to a certain risk level and, in the same way, it indicates the level of action to proceed.

### **2.5.2 Key Indicator Method (KIM)**

The first two KIM methods were developed and tested from 1996 to 2001 in connection with the implementation of the EU directives into German national legislation. They consist of two independent, but formally adaptable methods for lifting, holding, and carrying and for pulling, and Pushing. The KIM was drafted in the German Federal Institute for Occupational Safety and Health in close collaboration with the German Labour Inspectors (Steinberg, 2012).

To assess the risk, the most important factors (Key indicator) are selected, which have an ordinal scale ranging from zero to maximum. The objective of this method is to assess the risk of manual handling of loads, achieving this by assigning a rating score to each indicator, either for lifting/lowering/holding/ carry activities or push/pull activities and then a very simple calculation is made, following a respective formula.

These methods are implemented to evaluate the activities of this study later on. The REBA method is chosen because it evaluates the postures adopted by the worker for both the lower and upper limbs and takes into account the type of task, if it is dynamic, static or repetitive, besides takes into account the grip and the application of the load. On the other hand, the KIM method is considered because there are different types of activities to handle the load and this method encompasses all the necessary aspects to assess the risk of handling loads in the activities and conditions in which they are carried out.

### **3. METHODOLOGY**

In this chapter, the analysis techniques and methods used in order to reach the objectives are mentioned and described.

According to Maxwell & Oliveira (2011) the methodology must present how the research is conducted, it must be described in terms of objectives, techniques to collect the data and technique to analyze the data.

#### **3.1 Analysis method selection**

To analyse the different activities and work situations, techniques such as recording videos, taking photos and taking notes were all used in order to capture in detail each activity studied and its simultaneous movements .

The Portuguese version of the Nordic questionnaire (Mesquita et al., 2010) was used to analyse the musculoskeletal symptoms of the employees, studying nine body parts.

The tasks developed by the workers were evaluated by the KIM method (Key Indicator Method) which allows to assess the risk from the manual handling of loads (Klussmann, Steinberg, Liebers, Gebhardt, & Rieger, 2010) or by the REBA method (Rapid Entire Body Assessment) in situations in which certain positions and unpredictable movements were present (Hignett & McAtamney, 2000), in order to give recommendations and suggestions for changing the activities or the workplaces in order to decrease the risk situations detected.

The analysis of the data obtained was managed through the RStudio 1.1.463 program and the Excel program. The variables involved in the study allow one to analyse the data obtained with descriptive statistics (pie charts, bar charts).

#### **3.2 Sample size characterization**

Twenty-three workers participated in this study, 10 of them were men and 13 were women.

The workday is 8 hours, with a half-hour lunch period.

There are 3 professional functions to carry out the activities in the kitchen:

- Coordinator chef: responsible for the activities of his team, he must supervise and ensure that everything is done according to the plan created previously;
- Commis chef: responsible for preparing food and cleaning the workplace;

- Kitchen assistants: responsible for the previous preparations of vegetables or meats, provides assistance to chef or commis chef if necessary, cleaning work place, transporting food already prepared, serving food, washing dishes and pots.

The coordinator chef and the commis chef are usually in charge of transporting the food that is used during the day from the fridges, however, because they usually are under pressure during busy times the kitchen assistants also perform this activity.

### **3.3 Questionnaire description**

A questionnaire was used in order to collect information that allows the determination of musculoskeletal complaints of canteen professionals at Portuguese university under study, in order to analyse this information, find the potential risk factors, and make suggestions for the improvement of the workplaces.

The questionnaire developed was based on the Portuguese version of the Nordic Musculoskeletal Questionnaire (Mesquita et al., 2010). It is a reliable questionnaire and already validated before and some questions were added in order to gather more information.

An appointment was scheduled in the canteen. In this meeting, the questionnaire was given together with the authorization or informed consent (Annex 2) in which the study description, as well as the objective and the procedure on filling out the questionnaire, were provided. It was explained that the document should be signed by all the professionals who wanted to be part of the study.

The questionnaire is composed of two parts, Part A which allows to obtain demographic information and also professional aspects, such as: age, gender, career, practice sport, etc. Part B that allows to identify complaints and musculoskeletal symptoms of 9 body areas (neck, shoulders, upper back, elbows, lumbar region, wrists/hands, hips/thighs, knees, ankles/feet) considering some discomfort in the last 12 months and 7 days in each area of the body, as well as information about work absence in the last 12 months due to problems in any of the body areas. In addition the respondent should also indicate the degree of pain on a numerical scale from 0 to 10. For a better interpretation of the questions a sheet with a body diagram was attached (Annex 3).

### 3.4 Description of work activities

In this section, it will be defined and described the activities carried out in the canteen. The description will be made from the arrival of the raw ingredients to food delivery for the university community.

The raw material used for the preparation of canteen food is provided by different suppliers, who have the function of unloading those products from the trucks to a specific place in the canteen, close to both the truck and the warehouse. In this unloading the order is verified, usually by the shift manager.

The space of the canteen has three levels, at the level of the basement (floor -1), there is the kitchen in which are made the preparations and cooking and where the trucks arrive with the raw material. At the entrance level of the floor, or level 0, is the lunchroom where the food is served and floor 1 is another area called grill. However for this study, the upper one is not taken into account.

#### **Workplace 1: Unloading to warehouse**

This storage area includes different refrigerators and freezers in which vegetables, meat, fish, and foodstuffs are stored.

The employee transports the raw ingredients from the unloading area to the respective fridge or freezer through a wheeled cart trolley for supermarket, then it is organized according the FIFO (First In First Out) technique. This can be understood as "the first (product) to go into stock must be the first to leave also, avoiding the reach of the expiration of the item (Ribeiro, 2013).

The main activity performed in this work area is the transport and manual handling of loads, as seen in Figure 1 and Figure 2.





*Figure 1 - Unloading of raw material to the respective fridge*



*Figure 2 - Storage in the vegetable fridge*

## **Workplace 2: Peel potatoes and carrots**

The function in this work area is to peel vegetables such as potatoes or carrots through peeling machines. The main activity carried out is the handling of potato or carrot burlap sack, which

weight is around 20 kg. The employee is responsible for distributing them, in small buckets and then transported them to the respective machine to be peeled. Once this is finished, the employees are responsible for cleaning both the machines and the workplace, as shown in Figure 3 and Figure 4:



*Figure 3 - Potato sack handling*



*Figure 4 - Introducing potatoes in the peeling machine*

### **Workplace 3: Vegetable preparation**

The function in this work area is basically to prepare the vegetables that are used for cooking. The employee must bring the vegetables from the warehouse (workplace1). Depending on the quantity, they can be transported with the wheeled cart trolley for supermarket or without it.

After that, they are placed in the sink where there is soak with a special liquid to disinfect them (Suma Chlor) for at least 5 minutes (Figure 5). Then, they should be cut in the way they are necessary (Figure 6) depending on the menu to be prepared. Employees can perform this task standing up and in the same position for about 2 hours and half to 3 hours, and during this process, the vegetables are placed in food containers and organized in a fridge is nearby. There is a different procedure to storage the potatoes in the fridge, once they are peeled and cut, the employee in one of the wheeled carts places the potato in a bucket and proceeds to fill it with water, then it is transported to the fridge at a 5 meters distance (Figure7), this bucket weighs more or less 40kg. The cleanliness of the work area is the responsibility of the employees once they have completed the activity in this area.



*Figure 5 - Vegetable washing*



*Figure 6 - Cutting of vegetables*



*Figure 7 - Transport the potatoes already peeled and cut*

#### **Workplace 4: Cooking and preparing food**

This work area is composed of some workstations, which are used depending on the food dish that is made, these are the cookers, grill, ovens, soup pot and fryers.

Normally meat is transported with the wheeled cart trolley from the warehouse, it should be noted that the weight is usually between 160 and 180 kg.

Employees must keep in eye the preparation, perform activities such as stirring food (Figure 8), serving in the trays that will be taken to serve the food to the university community, transporting the pots from one place to another with wheeled cart trolley, take food into and out of the ovens (Figure 9), take soup from the large soup pot (Figure 10), grill food (Figure 11).

Generally, this activity takes approximately 2 hours and despite the employee is not in a static posture, he can do repetitive movements, as well as adopt uncomfortable postures.



*Figure 8 - Stirring food*



*Figure 9 - Baking food*





*Figure 10 - Taking the soup in smaller pots and then serving*



*Figure 11 - Grill area*

### **Workplace 5: Transportation of food from level -1 to level 0**

Once the food is ready, it is placed in stainless steel containers and transported with a wheeled cart trolley with the help of two people, and carried in the lift to the floor 0 (Figure 12). There, it is placed on the counter.

These same employees are the ones who are responsible to supply the counter with the food that is running out (Figure 13). At the same time they assist the people who are at the counter serving in what they may need.



*Figure 12 - Transporting food from level -1 to level 0*



*Figure 13 - Putting trays of food on the counter*

### **Workplace 6: Serving**

At this counter, there are usually 4 people (both employees and some collaborating students) who are responsible for serving the food to the university community (Figure 14). This activity takes approximately 3 hours. All the time they are standing up and performing the same movements.



*Figure 14 - Serving food*

### **Workplace 7: Washing dishes, glasses, trays and cutlery**

After finishing eating, people take the trays to a shelf (Figure 15) where they are stored, to proceed to wash. This washing area is only for dishes, glasses, trays and cutlery. It consists of two dishwashers, at the beginning of each one there are two workers. The first one who takes the tray from the shelf and remove the leftovers from the dishes (Figure 15), separate these from the glasses, cutlery and trays. The second person is in charge of organizing or placing these on the dishwasher Figure 16). Once the washing up is finished, there is a worker at the end of the dishwasher who is in charge of organizing and placing them in their respective places (Figure 17 and 18).

The cutlery from the dishwasher is taken to a table where they are dried. At this time a new method is being implemented to store the cutlery, which consists of performing the drying with rags and then they are placed in a storing cutlery (Figure 19), so the person who is going



to eat has to grab them. The method that was being used was to assemble a cutlery kit with napkins and placed all the elements in small paper bags (Figure 20). This initiative was taken into account in order to preserve the environment thus reducing the use of paper bags.



*Figure 15 - Removing leftovers*



*Figure 16 - Organizing dishes in the dishwasher*



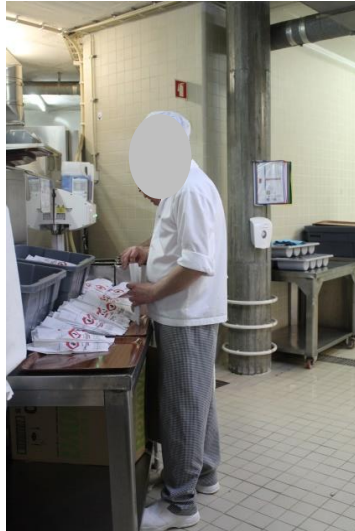
*Figure 17 - Organizing dishes after dishwasher has finished*



*Figure 18 - Taking clean glass to organize them*



*Figure 19 - Drying cutlery with rags*



*Figure 20 - Old method assembling a cutlery kit with napkins and placed in small paper bags*

### **Workplace 8: Washing of pots**

In this workplace, all pots, pans, trays in which food is cooked are washed.

Once the dirty pots arrive, they are left to soak for a while so that it is easier to wash them by hand, then the dirt that is stronger to clean is removed, until they are completely clean. It should be noted that the weight of these pots ranges from 20 to 25 kg, and due to these great magnitude they are not manipulated in the dishwasher. Most of the time the worker adopts uncomfortable postures mainly because the pots are on the floor. In Figure 21 can be seen different type of pots, pans, and trays.

The same worker always works in this area (Figure 22), during his daily work he only has one hour in which he performs another activity, frying the finger food for the others areas.



*Figure 21 - Type of pots, pans, trays washed in this area*



*Figure 22 - Washing pots*

After analyzing all the performed activities in the kitchen, the ones to be evaluated were selected. A schema of the activities to be study can be observed in Figure 23.

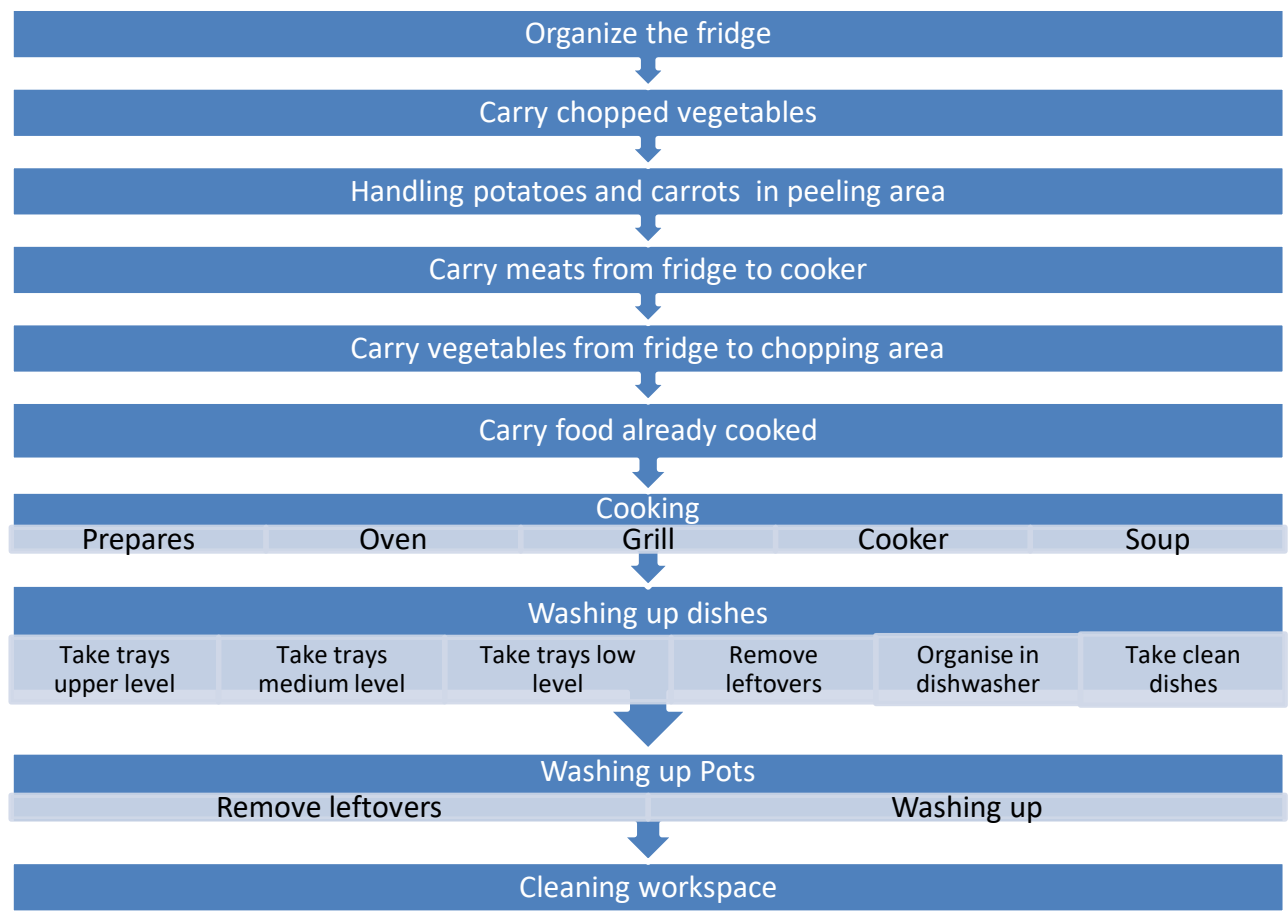


Figure 23 - Activities to be evaluated

### 3.5 Musculoskeletal Risk Assessment

Once information such as images, videos, and application of the questionnaire have been done, the tasks to be studied were selected taking into account manual manipulation of loads, repetitive movements, uncomfortable postures.

A total of 6 tasks were evaluated with the Kim method in which the risk factor is studied by manual handling of loads (Annex 4) and 4 tasks were evaluated with the REBA method in which repetitive movements and uncomfortable postures were taken into account (Annex 5).

## 4. ANALYSIS OF RESULTS AND DISCUSSION

This chapter shows the results obtained from the questionnaire as well as the results of the WMSD risk analysis obtained by applying the REBA and KIM methods.

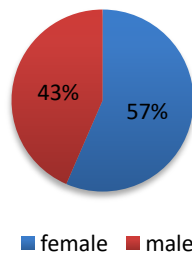
### 4.1 Questionnaire Analysis

The results of the questionnaire applied to 23 workers will be shown in the respective order of it, part A and part B.

#### 4.1.1 Part A Results and Analysis

The female prevails over the male, 13 of 23 respondents, corresponding to 57% of the sample (Figure 24).

**Gender: female and male**

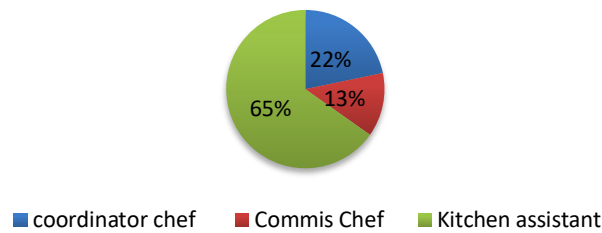


*Figure 24 - Gender chart*

The age of the respondents varies between 29 and 61 years old, the mean age is 48 years old (SD=9.8 years old).

Relating to the professional function, the largest number of employees are kitchen assistants. In the Figure 25 the distribution in terms of professional function is presented.

### Professional function



*Figure 25 - Professional Function*

The worker with higher seniority in this canteen has been working here for 36 years and the worker with less seniority works here only by 1 year. Therefore, the mean is 15 years (SD=10.39 years).

Most of these workers have several years of work experience in other industrial kitchens, one of them has 42 years of experience, according to the data analyzed, which can prove a long-standing experience. These results are shown at Table 1.

*Table 1. Work Experience in Industrial Kitchens (in years)*

MINIMUM	MAXIMUM	MEAN	MEDIAN	SD
1	42	18	19	12.06

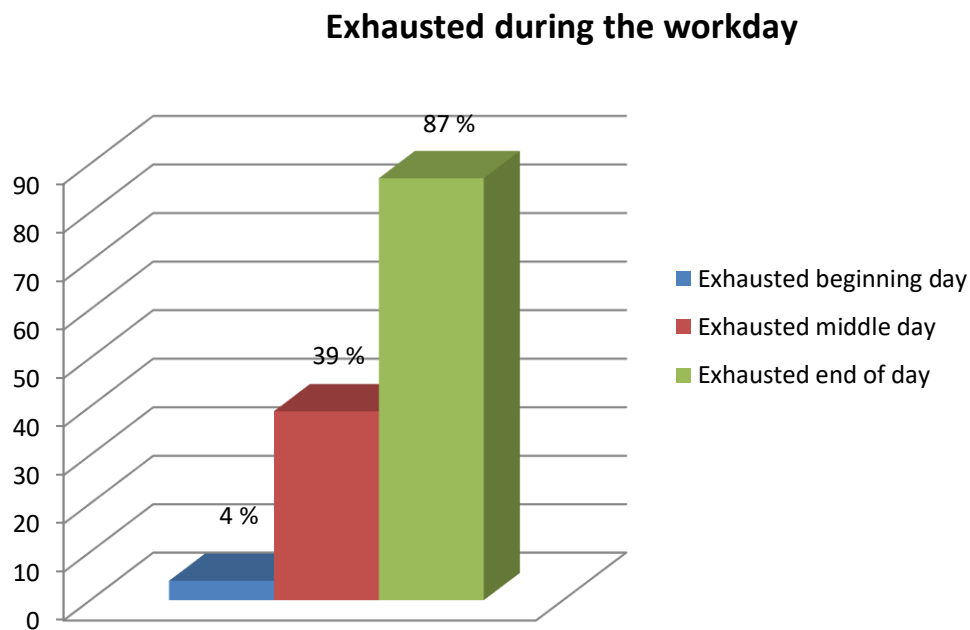
Despite the experience in industrial kitchens, people have exercised other professional activities before working in this place, at least 74% of the respondents said they have done it. Some of these activities included: dressmaker, factory workers, creche assistant, hotel trade, sellers, shoe factory, cleaning, waiters, barman, florists, etc. The respondents indicated the amount of time they have done these activities, as disclosed at Table 2.

*Table 2. Amount of time doing another's activities (in years)*

DESCRIPTION	MEAN	MEDIAN	SD	MIN	MAX
Experience	6	5	8.54	1	36

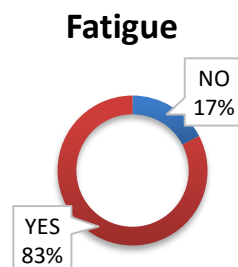
Regarding the question, if they practiced any sport, only 48% of the respondents answered affirmatively. Some of the activities practiced are: football, running, walking, bicycle, pilates, body jump, athletics, paddle, gym, among others.

Ninety-six percent of employees indicated that they feel exhausted at some time during the workday. Figure 26 shows percentage of affirmative answer for each situation (beginning, middle or end of the day) they could select more than 1 answer.



*Figure 26 - Workday exhaustion*

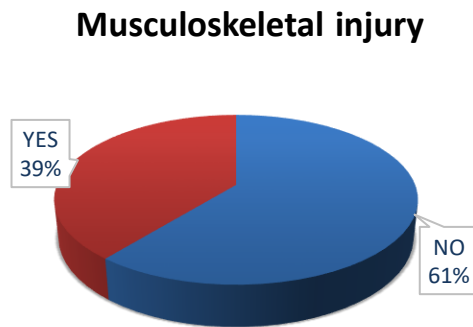
Eighty-three percent of employees attribute the fatigue to the work activity, as shown in Figure 27.



*Figure 27 - Fatigue due to work activity*



Despite the fatigue presented only 39% of employees have been diagnosed by the doctor regarding a musculoskeletal injury (Figure 28), respondents referred to both diseases and affected body areas, some of their responses are: cervical, hernia, arthritis, knees, shoulders, vertebrae L5, lumbar area.



*Figure 28 - Employees with a musculoskeletal injury diagnosed by a doctor*

#### 4.1.2 Part B Analysis and Results

In part B of the questionnaire employees refer to the symptoms associated with the nine parts of the body during the last 12 months, during the last 7 days, and if there was an impediment to perform daily life activities due to any musculoskeletal problem in the last 12 months.

Because there are three parts of the body, shoulders, elbows, and wrists, that have several options for laterality, the results will be divided into different tables. Table 3 summarizes these results for the body areas that have only one answer option.

Table 3. Summarize the results for 6 body area: for 12 months, 7 days, and impediment to perform daily activities in the last 12 months

DESCRIPTION	NO	%	YES	%	TOTAL
Neck 12 m	6	26	17	74	23
Neck 7d	9	39%	14	61%	23
Neck absenteeism	13	57%	10	43%	23
Ribcage 12m	15	65%	8	35%	23
Ribcage 7d	16	70%	7	30%	23
Ribcage absenteeism	18	78%	5	22%	23
Lumbar 12m	4	17%	19	83%	23
Lumbar 7d	6	26%	17	74%	23
Lumbar absenteeism	10	43%	13	57%	23
Hip 12m	15	65%	8	35%	23
Hip 7d	17	74%	6	26%	23
Hip absenteeism	18	78%	5	22%	23
Knee 12m	12	52%	11	48%	23
Knee 7d	12	52%	11	48%	23
Knee absenteeism	16	70%	7	30%	23
Feet 12m	6	26%	17	74%	23
Feet 7d	7	30%	16	70%	23
Feet absenteeism	12	52%	11	48%	23

Tables 4, 5 and 6 summarize the results for the other three body parts, shoulder, elbow and hand .

*Table 4. Discomfort in shoulders, elbows, and hands during the last 12 months*

<b>BODY AREA</b>	<b>NO</b>	<b>RIGHT</b>	<b>LEFT</b>	<b>BOTH</b>	<b>COUNT</b>
<b>Shoulder</b>	22%	30%	9%	39%	100%
<b>Elbow</b>	83%	9%	4%	4%	100%
<b>Hand</b>	30%	30%	9%	31%	100%

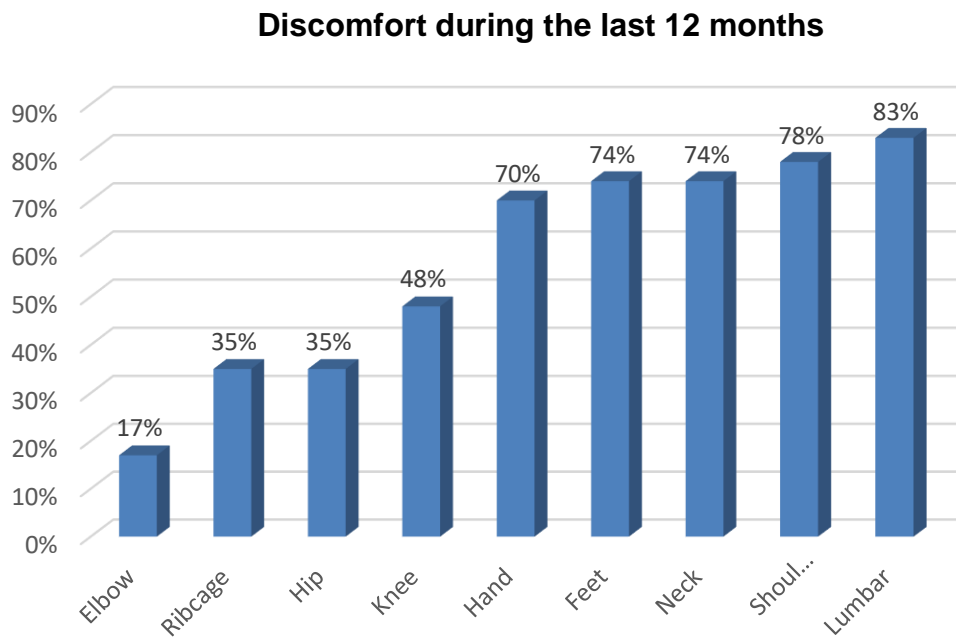
*Table 5. Discomfort in shoulders, elbows, and hands during the last 7 days*

<b>BODY AREA</b>	<b>NO</b>	<b>RIGHT</b>	<b>LEFT</b>	<b>BOTH</b>	<b>COUNT</b>
<b>Shoulder</b>	30%	35%	-	35%	100%
<b>Elbow</b>	87%	9%	4%	-	100%
<b>Hand</b>	35%	26%	9%	30%	100%

*Table 6. Impediment to perform daily life activities due to discomfort in shoulders, elbows, and hands, during the last 12 months*

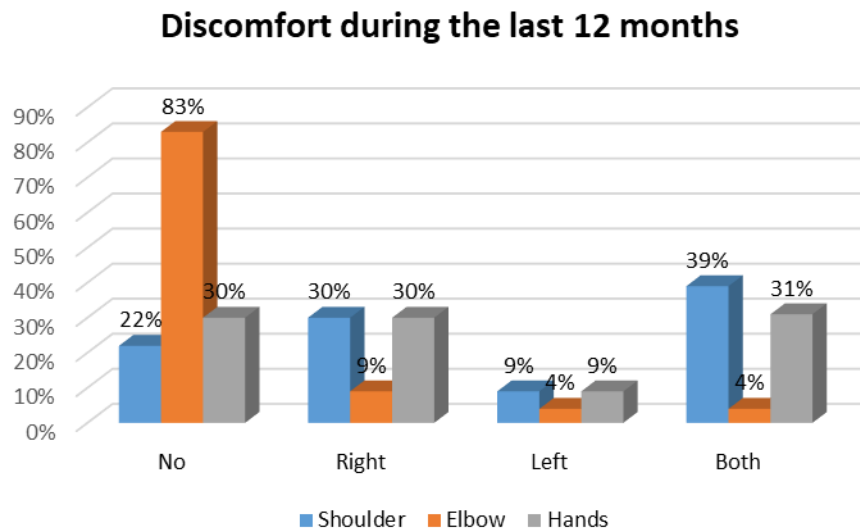
<b>BODY AREA</b>	<b>NO</b>	<b>RIGHT</b>	<b>LEFT</b>	<b>BOTH</b>	<b>COUNT</b>
<b>Shoulder</b>	52%	22%	4%	22%	100%
<b>Elbow</b>	91%	5%	4%	-	100%
<b>Hand</b>	52%	26%	9%	13%	100%

With the data above, the graphs of discomfort in the last 12 months, 7 days and impediment to perform daily life activities in the last 12 months are shown below, in Figures 29, 30, 31, 32, 33, and 34.



*Figure 29 - Discomfort for 6 body parts during the last 12 months*

Figure 29 shows that the lumbar area, shoulder, neck, feet and hands are the most affected body areas in the last 12 months, with the respective percentages of 83%, 78%, 74%, 74% and 70%.



*Figure 30 - Discomfort for 3 body parts during the last 12 months*

Figure 30 shows three areas of the body that reflect the type of laterality or both, it is observed that most of the employees have discomfort in both shoulders and hands with 39% and 31% respective and elbow has the highest percentage of comfort.

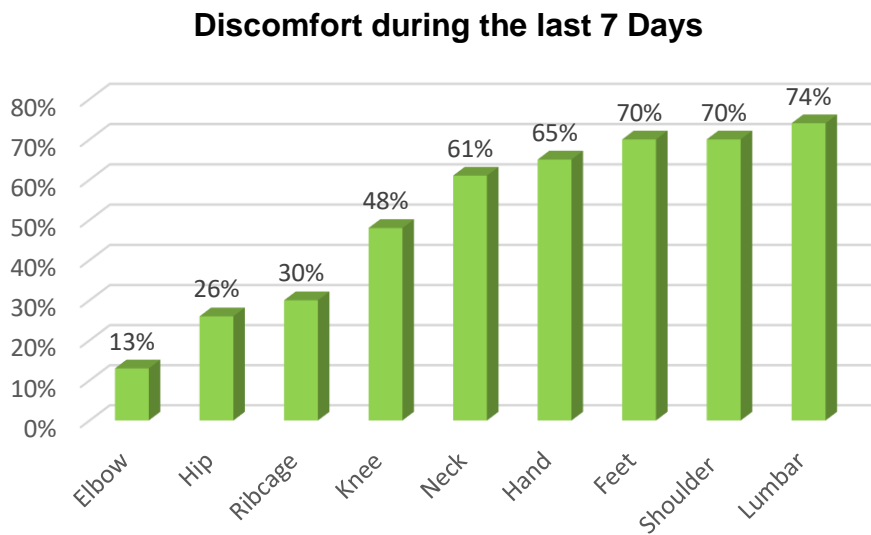


Figure 31 - Discomfort for 6 body parts during the last 7 days

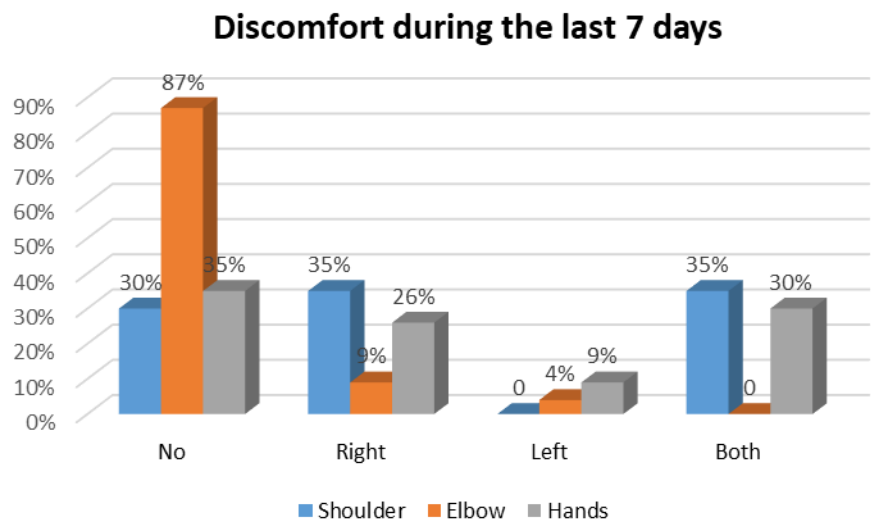


Figure 32 - Discomfort for 3 body parts during the last 7 days.

The fact that the employee has had musculoskeletal problems or complaints in the last 7 days varies between 13% for elbows and 74% for lumbar like is showed in Figure 31. However, taking into account Figure 32, there are also complaints of both shoulders with 35% and both hands 30%. At the same time, Figure 32 shows that the right side is more affected than the left and that the elbow is the lowest cause for complaint.

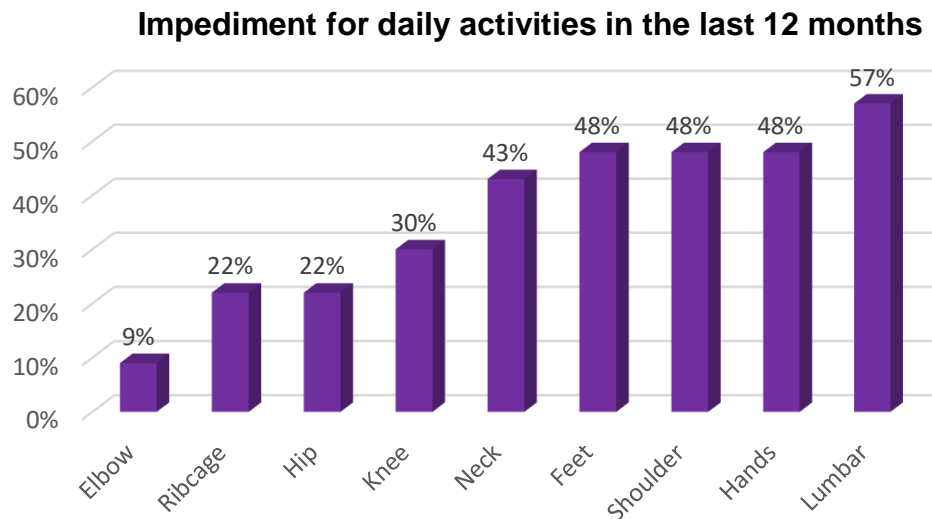


Figure 33 - Impediment for the daily activities due to musculoskeletal discomfort in 6 body parts, in the last 12 months

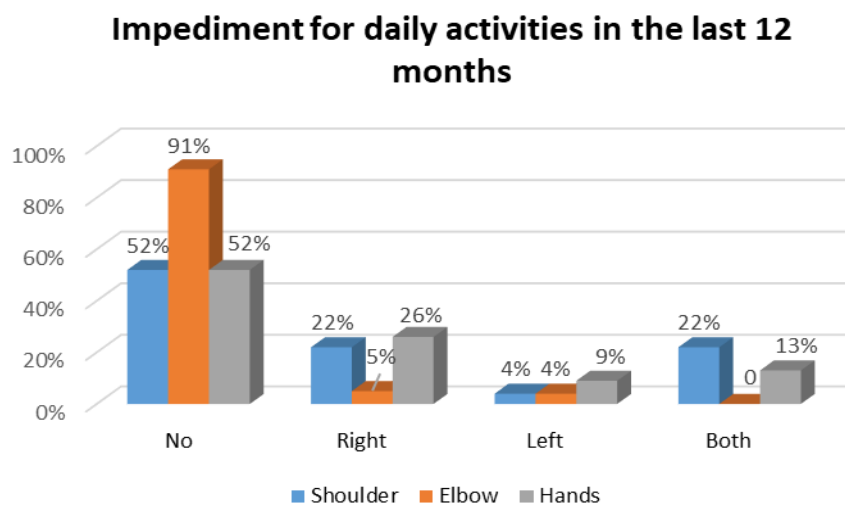


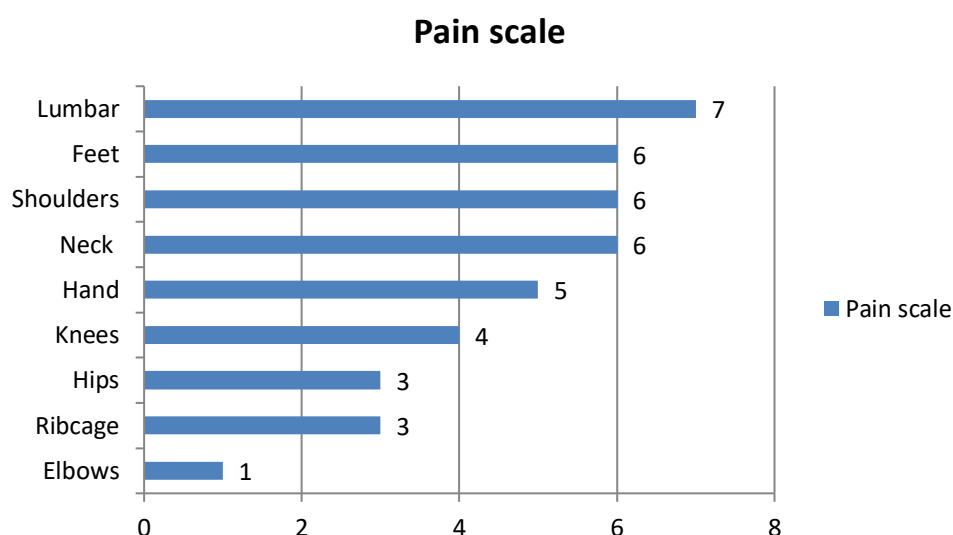
Figure 34 - Impediment for the daily activities due to musculoskeletal discomfort in 3 body parts, in the last 12 months

The body parts that most often prevent workers from performing their daily activities are the lumbar area 57%, hands, shoulders and feet 48%, neck 43%.

For shoulders, elbows and hands the right side is the most common that prevents performing the daily activities, as shows Figure 34.

On the other hand, in the questionnaire, the employee had a scale to determine the pain for each part of the body, that scale ranged from 0 (no pain) to 10 (maximum pain).

According to Figure 35 the lumbar area on average has a score of 7 points followed by the feet, shoulders, and neck with 6.



*Figure 35 - Average pain scale for the 9 areas of the body*

The results of this study coincide with the results obtained in another study where the author applied the Nordic questionnaire, obtaining the lumbar area, neck, and feet the same prevalence of complaints (Costa, 2017).

In another study developed in municipal kitchens of schools, the complaints in the body part of women were evaluated. They presented discomfort in different body areas like low back, neck, shoulder, forearm, and hand (Riihima, 2006). A similar study conducted for professional male kitchen workers in school lunch services shows 72.2% of low back pain (Nagasu et al., 2007)

## 4.2 Musculoskeletal risk assessment and recommendations

In addition to applying the questionnaire to get an idea of the musculoskeletal complaints, the images and videos of the activities were studied in order to evaluate the postures adopted during their performance and assess the risk level of musculoskeletal injury with the REBA method that, as previously mentioned, allows assessing the work postures and, consequently, the correspondent risk level. In addition to the above, the tasks involving manual material handling were analyzed with the KIM method.

### 4.2.1 Assessment based on the tasks evaluated with REBA

At the point in time when evaluated the videos and images captured of the activities carried out, those having unexpected posture changes were chosen. Those that had the greatest postural load due to the execution time, the repetitiveness or because they presented greater deviation from the neutral position were selected.

Once the final value provided by the REBA method is obtained, it indicates the risk value of the occurrence of musculoskeletal injury, and also the correspondent required action. Table 7 shows these risk levels.

*Table 7. REBA risk level*

REBA Level	REBA Score	Risk Level	Required Action
0	1	Negligible	Not necessary
1	2 - 3	Low	May be necessary
2	4 - 7	Medium	Necessary
3	8 - 10	High	Necessary soon
4	11-15	Very high	Necessary now



With the REBA method, 4 activities were analyzed, and some of them were divided into subactivities. Table 8 shows an example.

*Table 8. Example of division of an activity in subactivities*

ACTIVITY	SUB ACTIVITY
<b>Washing dishes</b>	Take trays upper level
	Take trays medium level
	Take trays low level
	Remove leftovers
	Organise in dishwasher
	Take clean dishes

The workers with the worst adopted postures in the different activities were selected. These activities were evaluated to obtain the risk level of musculoskeletal injury, applying the REBA method. The level of risk was obtained and an example is in Table 9, the rest is in Annex 6.

*Table 9. Example of REBA Analysis performed on the washing dishes activity*

Activity	Sub activity	Group A			L	S A	Grupo B			G	S B	C	REBA		
		Trunk	Neck	Leg	Load	Score A	Arm	Forearm	Wrist	Grip	Score B	Correction	REBA Score	Action level	Risk Level
Washing dishes	Take trays upper level	1	2	1	0	1	5	2	2	1	9	1	7	2	Medium
	Take trays medium level	1	2	1	0	1	4	1	2	1	6	1	4	2	Medium
	Take trays low level	4	2	4	0	8	2	2	2	1	4	1	10	3	High
	Remove leftovers	3	2	1	0	4	4	2	2	1	7	1	8	3	High
	Organise in dishwasher	3	2	1	0	4	3	2	2	0	5	2	7	2	Medium
	Take clean dishes	3	3	1	0	5	3	2	3	1	6	1	7	2	Medium

In order to obtain the level of risk by activity, the average of the subactivities score was obtained. Table 10 summarizes the REBA scores for each activity analyzed.

Table 10. Final REBA risk level for each evaluated activity

ACTIVITY	REBA SCORE	RISK LEVEL
Cooking	9	High
Washing dishes	7	Medium
Washing pots	11	Very High
Cleaning	10	High

According to the results shown in the table 10, the cooking activity has a high level of risk. In general the work done in the kitchen is in a standing position, in which one has to bend down, turn or twist the body, adopting incorrect postures, making inappropriate movements leading to worker fatigue.

In activities such as peeling or cutting, as Figure 36 shows, it is possible to avoid standing for long periods of time by performing these tasks in a semi-sitting position, for them a chair can be used, avoiding the accumulation of time in standing position and reducing lower limb overload, besides reducing the extreme flexion of the neck.

It is advisable to also use ergonomic knives, which facilitate the grip of the same and keeps the hand and wrist in a neutral and comfortable position reducing the effort to cut.

Make aware the workers for the adoption of correct postures, to ensure the flexion of the arm preferably between  $-20^{\circ}$  to  $20^{\circ}$  and the flexion of the forearm between  $60^{\circ}$  to  $100^{\circ}$  (Hignett & McAtamney, 2000), to avoid flexion and twisting of the trunk like is shown in Figure 37.

Avoid storing raw food in large containers to be used later avoid maximum flexion of the trunk. As an alternative measure they can be stored in small containers that can be transported by trolleys allowing an easy access to these foods that will be baked (Figure 38).

In the area of the soup (Figure 39) is recommended to avoid manual movement of the liquid. On the contrary, robots should be used, avoiding the efforts of the upper limbs and exposure to steam.



*Figure 36 - Cutting vegetables*



*Figure 37 - Bad posture taken while cooking*



*Figure 38 - Awkward posture taken to reach food in large containers*



*Figure 39 - Stirring soup without the robot*

In the activity of washing dishes it was observed that the level of risk was medium, so, when removing the trays from trolleys, the postures must be taken into account. For example, workers should avoid bending the back to take the trays from the bottom. Workers should have straight back and flex the legs so as to lift the load using the muscles of the legs and not the back.

Regarding the containers organization, where the cutlery is deposited to be soaked, they could be placed on the same counter to prevent the person who is removing the leftovers turn the trunk or even move the arm back (extension). This situation is illustrated in Figure 40. In case it could not be placed on the same counter, the worker should be instructed to move the feet so the body is turned completely and not just the trunk.



*Figure 40 - Removing leftovers from dishes*

In the activity of washing pots, as is shown in the Figure 41 and Figure 42, the risk level is very high, being the main reason of it the fact that the worker adopts very uncomfortable postures like bending the trunk even  $60^\circ$  because of the large size of the pots and the absence of a place to put them while they are soaked to soften the leftovers. A possible solution could be to put a continuous counter beside the sink, where one could place the pots avoiding doing the activity of remove leftovers on the floor and finishing to wash them. this means redesigning the workstation, as for the sink and counter due to the washed utensils great size. Taking into account that the weight of the pots is around 20 kg and there are many pots, pans and other trays that are washed in this area throughout the day, it is recommended that in this workplace more than one person should be working the whole day and every day. This means

that it should be at least two persons working simultaneously, and during the day workers' rotativity should be implemented.



*Figure 41 - Removing leftovers from pots and washed them*



*Figure 42 - Area of handling big pots*

During the evaluation of the job of peeling potatoes and carrots, the workers indicated unsatisfaction at the time of cleaning these machines, due to their height (Figure 43). In this sense, it should be remembered that the equipments should be adapted to the anthropometric dimensions of the workers, taking into account their individual variations. Measures such as steps should be established so small people will be not affected and can perform their cleaning in a safe and enjoyable way.

In general, in the cleaning functions such as cleaning floors, counters, machines, as is shown in Figure 44, people should take into account or beware of the postures that must be taken at the time of performing them, avoiding bending the back to reach the lower parts of these machines or counter (Figure 45). On the contrary, the back should be kept straight, bend the knees, in order to avoid the impact in the lumbar area as well as avoiding flex or extend the neck.

To clean floors, it is recommended keeping the back straight, extend arms and move the whole body to advance with both feet since the most common is that the worker flexes the trunk too much and tries to reach with the broom or mop the maximum area without moving



the feet. This posture impact once more on the lumbar area and upper limbs by the excessive extension done.



*Figure 43 - Cleaning the potatoes peel machine*



*Figure 44 - Cleaning carrots machine*



*Figure 45 - Cleaning counters*

#### 4.2.2 Assessment based on the tasks evaluated with KIM

The activities consisting of manual handling of loads, which are responsible in many cases for the appearance of physical fatigue, or for injuries that can occur immediately or by accumulation of minor trauma, were evaluated. In this case, the method used to evaluate this type of activity was the KIM method.

There are two ways to apply this method, depending on the activity to be carried out. Therefore it is divided into two parts: lifting/lowering/hold/carry activities and push/pull activities.

#### A. Lifting/lowering /hold/carry activities


To determine the total risk associated with the activity, certain values that are involved in the activity must be chosen, in order to apply the formula and be able to know the risk level. Below is presented the example of one of the activities, the rest of them are in Annex 7. The Risk Level of KIM method is show in the Figure 46.

##### Activity 1: Organize the fridge.

Load score (4) + posture score and load position (4) + score of working conditions (1) = (9)

Total (9) \* time score (4) = (36) total risk score.

Based on the total score calculated and the safety chart presented a risk análisis can be performed.

Risk Level		Risk Score	Description
1		<10	Low load situation, physical overload is improbable
2		10 < 25	Situation of increased load, probable physical overload for people with less strength. For this group a revaluation is useful.
3		25 < 50	High load situation, also probable physical overload for normal people. Revaluation of the workplace is recommended
4		≥ 50	Very high load situation, physical overload is probable. Revaluation of the workplace is needed

*Figure 46 - Risk level of KIM for lifting/lowering/hold/carry activities*

Table 11 summarizes the lifting/lowering/hold/carry activities evaluated with the KIM method.

Table 11. Final KIM Risk level lifting / lowering / hold / carry activities

ACTIVITY	RISK SCORE	RISK LEVEL
Organize the fridge	36	3
Carry chopped vegetables	14	2
Handling potatoes and carrots in peeling area	18	2



Figure 47 - Organize the fridge



Figure 48 - Carry chopped vegetables





*Figure 49 - Storage in the fridge of already chopped vegetables*



*Figure 50 - Taking the potatoes burlap sack*



*Figure 51 - Distribute potatoes in small buckets*



Figure 52 - Introduce the potatoes to be peeled

## B. Push/pull activities

In this type of activity, the values to apply the formula must be obtained in order to obtain the level of risk associated with the activity. An example of an activity can be seen below, the rest of them are in the Annex 8.

### Activity 5: carry vegetables from fridge to chopping area

score of speed and accuracy movement (2) + load score (1) + posture score (4) + score of working conditions (8) = 15

Total (15) \* time score (2) = (30) total risk score

Based on the total score calculated and the table below it is possible to make a risk analysis


Risk Level		Risk Score	Description
1		<10	Light load situation, the emergence of physical overload is improbable.
2		10 < 25	Medium load situation, the emergence of physical overload for people with less strength. For this group, workplace modification may be favorable.
3		25 < 50	Increased load situation, the emergence of physical overload is also possible in people with normal strength. Modification of the workplace is recommended.
4		≥ 50	Very high load situation, physical overload is probable. Workplace modification require

Figure 53 - Risk level of KIM for Push/Pull activities

Table 12 summarizes the Push/Pull activities evaluated with the KIM method

*Table 12. Final KIM risk level Push/Pull activities*

ACTIVITY	RISK SCORE	RISK LEVEL
Carry meats from fridge to counter	16	2
Carry vegetables from fridge to chopping area	30	3
Carry food already cooked	14	2

The results shown in terms of manual handling of loads have a medium level of risk except for two activities that the risk is high. Therefore, what should be done is to make the worker aware of how to carry out these load either manually or mechanically. In short, programs that provide adequate training and information on the risks arising from manual handling load should be considered.

Basic information regarding the manual handling of loads such as:

- Separate the feet to provide a stable and balanced posture for lifting
- Bend your legs while keeping your back straight at all times, do not bend your knees too much, do not turn your trunk or adopt forced postures.
- Stand up gently, by extension of the legs, keeping the back straight. Do not pull the load or move it quickly or abruptly.
- Try never to make turns, it is preferable to move your feet to get in the right position
- Keep the load attached to the body during the entire lift.

- Request help from other people if the weight of the load is excessive or uncomfortable postures should be taken during lifting.

In the activities of transporting meats or vegetables through the ramp in wheeled cart trolley, as show Figure 55 and Figure 56, it is recommended to avoid transporting through that ramp. As an alternative a mechanical ramp should be placed in order to avoid the effort exerted by the worker. A high scissors lifting table could be a solution, so the worker receives the raw material above and then transport the load at that floor level, through the trolleys.



*Figure 54 - Carry meats from fridge to conter*



*Figure 55 - Carry vegetables from fridge to chop área*

In the activity in which they transport the food already prepared to the floor 1, it can be noticed that the carts used only have a low handle tube, which affects the position adopted at

the time of pushing the cart shown in Figure 57. Usually this activity is done by 2 people, and the second person does not have any grip or handle the tube thus this person need to bend the trunk when trying to grip the first level of cart. Its recommended to get other cart with at least the two handle tubes.

Teamwork by rotating tasks or handling loads by two people can reduce the stress by a single worker in handling loads.



*Figure 56 - Carry food already cooked*

In general, it is recommended to inform or train employees about preventive measures to avoid risks to which they are exposed daily. Implementing employee rotation to avoid repetitive movements for long periods of time or at least rotate some activity where do not use the same set of muscles.

## 5. CONCLUSIONS

Risk assessment is a process that allows organizations to detect risks that can affect the safety and health of workers. This work analysed ergonomic factors such as: adopted postures, load handling, repetitive movements, in order to identify the main ergonomic risk factors caused in the workers of the university canteen. The employees were observed in their daily activities, identifying those activities in which they presented risks to their health. A questionnaire based on the Nordic questionnaire was applied to obtain information regarding the parts of the body in which the workers have presented pain in the last 12 months and 7 days, or absenteeism in the last 12 months. It was obtained that kitchen employees have been exposed to high risk of muscle fatigue in the last 12 months in the lumbar area 83%, shoulder 78%, feet 74% and neck 74%. Through the application of the REBA and KIM methods the selected activities were evaluated in order to obtain the risk levels to which workers are exposed. Improvements were suggested for each of these activities, taking into account the possibility of implementation.

It is essential to implement a good rotational plan, because workers during the week perform the same activities every day. So if they have a weekly rotation, it would directly influence the occurrence of musculoskeletal injuries. Even the job with the highest level of risk in this study, which is the washing of pots, does not have a rotation. A single person does this job during the whole day and whole week, requiring an immediate intervention.

Employees are aware of the pain they suffer because of the work-related fatigue. This is a point in favour of the organization at the time of raising awareness through formations about the risks to which they are exposed, letting them to account the consequences in short and long term if not following the information regarding to the good way to accomplish activities.

Therefore, can be affirmed that ergonomic factors such as uncomfortable postures, repetitive movements, improper handling of loads, lack of activities rotation are the cause of the occurrence of musculoskeletal disorders.

In future work, psychosocial factors, stress and increased productivity should be studied because they can be related to the risk of musculoskeletal disorders.

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## ANNEX 1 – IMPEDIMENT TO PERFORM DAILY LIFE ACTIVITIES

Data de admissao	Dias de baixa desde admissão	Dias de baixa 2018
<b>01/05/1991</b>	<b>1130</b>	<b>242</b>
<b>01/03/1991</b>	<b>0</b>	<b>0</b>
<b>02/01/1996</b>	<b>780</b>	<b>7</b>
<b>02/09/1996</b>	<b>12</b>	<b>12</b>
<b>02/01/1997</b>	<b>63</b>	<b>0</b>
<b>25/02/1997</b>	<b>21</b>	<b>0</b>
<b>02/01/1998</b>	<b>415</b>	<b>7</b>
<b>13/11/1997</b>	<b>159</b>	<b>15</b>
<b>01/10/1999</b>	<b>20</b>	<b>0</b>
<b>02/11/1999</b>	<b>73</b>	<b>19</b>
<b>23/10/2000</b>	<b>1230</b>	<b>365</b>
<b>01/09/2001</b>	<b>74</b>	<b>0</b>
<b>30/12/2009</b>	<b>15</b>	<b>3</b>
<b>30/12/2009</b>	<b>143</b>	<b>25</b>
<b>01/03/2012</b>	<b>12</b>	<b>12</b>
<b>01/05/2015</b>	<b>131</b>	<b>42</b>
<b>01/09/2015</b>	<b>69</b>	<b>26</b>
<b>01/11/2015</b>	<b>0</b>	<b>0</b>
<b>24/05/2018</b>	<b>0</b>	<b>0</b>
<b>24/05/2018</b>	<b>0</b>	<b>0</b>
<b>01/10/2018</b>	<b>0</b>	<b>0</b>
<b>23/10/2018</b>	<b>0</b>	<b>0</b>

## ANNEX 2 – AUTHORIZATION OR INFORMATION CONSENT

### CONSENTIMENTO INFORMADO PARA UTILIZAÇÃO DE DADOS

**Objetivo Geral da dissertação de mestrado:** Avaliar e caracterizar o risco de desenvolvimento de lesões musculoesqueléticas em profissionais da cantina de Azurém da Universidade do Minho.

**Investigadores envolvidos:** Nathaly Gómez (aluna do Mestrado em Engenharia Humana da Universidade do Minho); Paula Carneiro (Professora Auxiliar do DPS - Universidade do Minho).

**Procedimentos:** Ser-lhe-á disponibilizado um questionário em papel. Depois de preenchido devolva-o, por favor, à investigadora Nathaly. Durante o desenvolvimento das suas atividades profissionais serão recolhidas algumas imagens com o intuito de, posteriormente, se proceder a uma análise ergonómica e respetivo risco de lesão musculoesquelética associado.

Todos os dados registados no questionário, assim como as imagens recolhidas durante o exercício da sua atividade profissional, serão tratados de forma confidencial, nunca sendo divulgado qualquer dado que permita a sua identificação.

A participação neste estudo é totalmente voluntária e contribuirá para a caracterização da sintomatologia de origem musculoesquelética em profissionais que exercem a sua atividade na cantina da Universidade do Minho, em Azurém. Nesse sentido, solicitamos-lhe que responda ao questionário do modo mais honesto possível.

Caso pretenda, poderá desistir a qualquer momento da participação neste estudo, sem que incorra em qualquer prejuízo.

Eu, abaixo assinado, aceito participar na recolha de dados do Projeto de dissertação acima referido, conhecendo o objetivo e o contexto em que vai decorrer o mesmo.

Assinatura do(a) Participante: \_\_\_\_\_

Data: \_\_\_\_\_

#### Investigadoras responsáveis

Nathaly Gómez (aluna do MEH)  
[calderonalbercely@gmail.com](mailto:calderonalbercely@gmail.com)

Paula Carneiro (docente orientadora da aluna - Universidade do Minho)  
[pcarneiro@dps.uminho.pt](mailto:pcarneiro@dps.uminho.pt)

## ANNEX 3 – QUESTIONNAIRE (4 PAGES)

### PARTE A:

#### Avaliação da sintomatologia musculoesqueléticas em operadores de uma cozinha industrial

1.- Idade

2.- Sexo

☐

Feminino

☐

Masculino

3.- Função Profissional

☐

Cozinheiro Coordenador

☐

Cozinheiro

☐

Auxiliar de Alimentação

4.- Antiguidade na Empresa (anos)

5.- Horas semanais de trabalho

6.- Há quanto tempo trabalha em cantinas ou cozinhas industriais?

7.- Antes desta atividade, exerceu outro tipo de atividade profissional?

☐

Não

☐

Sim

**Indique Qual:**

**Por quantos anos:**

8.- Faz exercício físico de uma forma regular?

☐ Não

☐ Sim

**Indique Qual:**

**Há quanto tempo:**

9.- Durante a sua atividade de trabalho diária costuma sentir-se exausto em algum momento?

☐ Não

☐ Sim

**Selecione o momento do turno de trabalho em que isso costuma acontecer:**

☐ No início do dia de trabalho

☐ A meio do dia de trabalho

☐ No fim do dia de trabalho

10.- No caso de apresentar dor e/ou fadiga, atribui isso:

☐ À sua atividade profissional

☐ A outro tipo de atividade, não profissional

Indique o(s) motivo(s) de uma forma sucinta:

11.- Tem alguma lesão musculoesquelética (caraterizada pelo médico)?

☐ Não

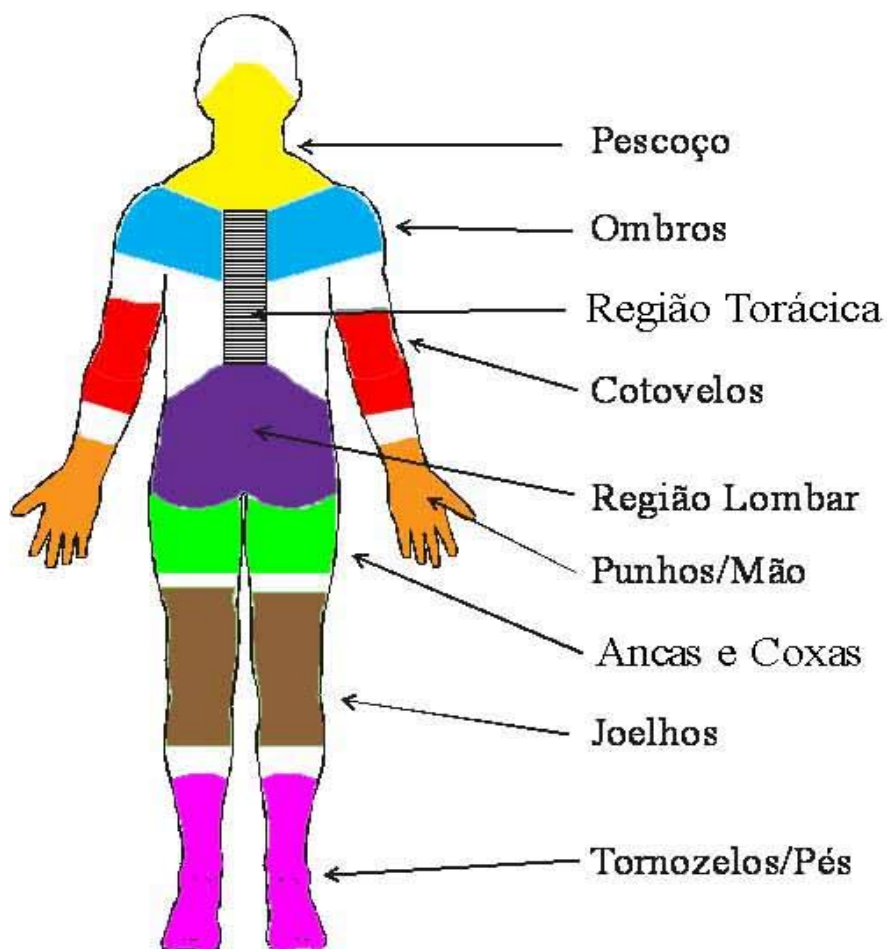
☐ Sim

**Qual:**

## PARTE B: Questionário Nórdico Músculo-esquelético

### Instruções para o preenchimento

- Por favor, responda a cada questão assinalando um "X" na caixa apropriada: ☒
- Marque apenas um "X" por cada questão.
- Não deixe nenhuma questão em branco, mesmo se não tiver nenhum problema em qualquer parte do corpo.
- Para responder, considere as regiões do corpo conforme ilustra a figura abaixo.



Idade \_\_\_\_\_ Data de nascimento \_\_\_\_ / \_\_\_\_ / \_\_\_\_ Sexo \_\_\_\_\_ Data de hoje \_\_\_\_ / \_\_\_\_ / \_\_\_\_  
 Posto de trabalho \_\_\_\_\_ Estado civil \_\_\_\_\_

Responda, apenas, se tiver algum problema																							
Considerando os últimos 12 meses, teve algum problema (tal como dor, desconforto ou dormência) nas seguintes regiões:	Durante os últimos 12 meses teve que evitar as suas actividades normais (trabalho, serviço doméstico ou passatempos) por causa de problemas nas seguintes regiões:																						
1. Pescoço?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	2. Pescoço?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
5. Ombros?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no ombro direito 3 <input type="checkbox"/> no ombro esquerdo 4 <input type="checkbox"/> em ambos	6. Ombros?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no ombro direito 3 <input type="checkbox"/> no ombro esquerdo 4 <input type="checkbox"/> em ambos																						
9. Cotovelo?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no cotovelo direito 3 <input type="checkbox"/> no cotovelo esquerdo 4 <input type="checkbox"/> em ambos	10. Cotovelo?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no cotovelo direito 3 <input type="checkbox"/> no cotovelo esquerdo 4 <input type="checkbox"/> em ambos																						
13. Punho/Mãos?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no punho/mãos direitos 3 <input type="checkbox"/> no punho/mãos esquerdos 4 <input type="checkbox"/> em ambos	14. Punho/Mãos?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> no punho/mãos direitos 3 <input type="checkbox"/> no punho/mãos esquerdos 4 <input type="checkbox"/> em ambos																						
17. Região Torácica?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	18. Região Torácica?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
21. Região Lombar?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	22. Região Lombar?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
25. Ancas/Coxas?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	26. Ancas/Coxas?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
29. Joelhos?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	30. Joelhos?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
33. Tornozelo/Pés?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	34. Tornozelo/Pés?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
3. Pescoço?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>	35. Tornozelo/Pés?  Não <input type="checkbox"/> Sim <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/>																						
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0	1	2	3	4	5	6	7	8	9	10													

## ANNEX 4 – KIM METHOD (4 PAGES)

### ASSESSMENT OF MANUAL HANDLING TASKS BASED ON KEY INDICATORS Version 2001

Where there are a number of individual activities with considerable physical strains, they must be estimated separately.

Workplace/Activity:


**1<sup>st</sup> step: Determination of time rating points** (Select only one column!)

Lifting or displacement operations (< 5 s)		Holding (> 5 s)		Carrying (> 5 m)	
Number on working day	Time rating points	Total duration on working day	Time rating points	Overall length on working day	Time rating points
< 10	1	< 5 min	1	< 300 m	1
10 to < 40	2	5 to 15 min	2	300 m to < 1 km	2
40 to < 200	4	15 min to < 1 hr	4	1 km to < 4 km	4
200 to < 500	6	1 hrs to < 2 hrs	6	4 to < 8 km	6
500 to < 1000	8	2 hrs to < 4 hrs	8	8 to < 16 km	8
≥ 1000	10	≥ 4 hrs	10	≥ 16 km	10
<b>Examples:</b> • laying bricks, • placing workpieces into a machine • taking boxes out of a container and putting them onto a conveyor belt		<b>Examples:</b> • holding and guiding a cast iron slug while working on a wheel stand, • operating a hand grinding machine, • operating a weed-eater		<b>Examples:</b> • furniture removal, • delivering scaffolding parts to a building site	

**2<sup>nd</sup> step: Determination of rating points of load, posture and working conditions**

Effective load <sup>1)</sup> for men	Load rating point	Effective load <sup>1)</sup> for women	Load rating point
< 10 kg	1	< 5 kg	1
10 to < 20 kg	2	5 to < 10 kg	2
20 to < 30 kg	4	10 to < 15 kg	4
30 to < 40 kg	7	15 to < 25 kg	7
≥ 40 kg	25	≥ 25 kg	25

1) „Effective load“ means in this context the real action force which is necessary for moving load. This action force does not correspond to the load mass in each case. When lifting a carton, only 50 % of the load mass will have an effect on worker and when using a cart only 10 %.

Typical posture, position of load <sup>2)</sup>	Posture, position of load	Posture rating point
	<ul style="list-style-type: none"> <li>Upper body upright, not twisted</li> <li>When lifting, holding, carrying and lowering the load is close to body</li> </ul>	1
	<ul style="list-style-type: none"> <li>Slightly bending forward or twisting the trunk</li> <li>When lifting, holding, carrying and lowering load is near to medium to body</li> </ul>	2
	<ul style="list-style-type: none"> <li>Low bending or far bending forward</li> <li>Slightly bending forward with simultaneous twisting of trunk</li> <li>Load far from the body or above shoulder height</li> </ul>	4
	<ul style="list-style-type: none"> <li>Bending far forward with simultaneous twisting of trunk</li> <li>Load far from body</li> <li>Restricted stability of posture when standing</li> <li>Crouching or kneeling</li> </ul>	8

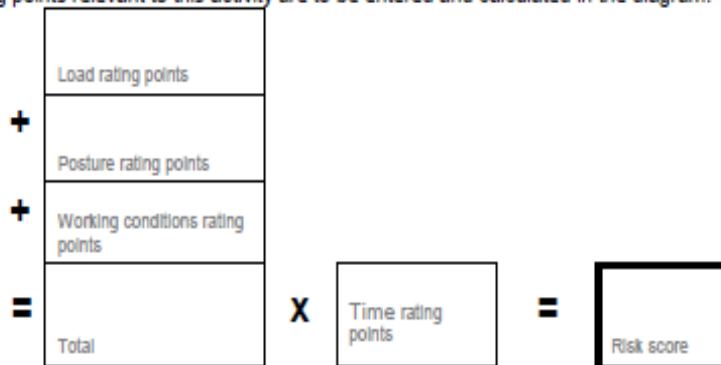
2) To determine the posture rating points the typical posture during manual handling must be used. For example when there are different postures with load a mean value must be used – not occasional extreme values.



Working conditions	Working conditions rating point
Good ergonomic conditions, e.g. sufficient space, no physical obstacles within the workspace, even level and solid flooring, sufficient lighting, good gripping conditions	0
Space for movement restricted and unfavourable ergonomic conditions (e.g. 1: space for movement restricted by too low high or working area less than 1,5 m <sup>2</sup> or 2: posture stability impaired by uneven floor or soft ground)	1
Strongly restricted space of movement and/or instability of centre of gravity of load (e.g. transfer of patients)	2

### 3<sup>rd</sup> step: Evaluation

The rating points relevant to this activity are to be entered and calculated in the diagram.



On the basis of the rating calculated and the table below it is possible to make a rough evaluation.<sup>3)</sup> Regardless of this provisions of the Maternity Leave Act apply.

Risk range	Risk score	Description
1	< 10	Low load situation, physical overload unlikely to appear.
2	10 bis < 25	Increased load situation, physical overload is possible for less resilient persons <sup>4)</sup> . For that group redesign of workplace is helpful.
3	25 bis < 50	Highly increased load situation, physical overload also possible for normal persons. Redesign of the workplace is recommended.
4	≥ 50	High load situation, physical overload is likely to appear. Workplace redesign is necessary <sup>5)</sup> .

<sup>3)</sup> Basically it must be assumed that as the number of point rating rises, so the risk of overloading the muscular-skeletal system increases. The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. More exact analyses require specialist ergonomic knowledge.

<sup>4)</sup>

## Assessment of pulling and pushing based on key indicators *Version Sept. 2002*








The overall activity must be broken down into individual activities. Each individual activity involving major physical strain must be assessed separately.

Workplace/Activity:

### 1st step: Determination of time rating points *(Select only one column)*

Pulling and pushing over short distances or frequent stopping (single distance up to 5 metres)		Pulling and pushing over longer distances (single distance more than 5 metres)	
Number on working day	Time rating points	Total distance on working day	Time rating points
< 10	1	< 300 m	1
10 to < 40	2	300 m to < 1 km	2
40 to < 200	4	1 km to < 4 km	4
200 to < 500	6	4 to < 8 km	6
500 to < 1000	8	8 to < 16 km	8
≥ 1000	10	≥ 16 km	10
<i>Examples: operation of manipulators, setting up machines, distribution of meals in a hospital</i>		<i>Examples: garbage collection, furniture transport in buildings on rollers, unloading and transloading of containers</i>	

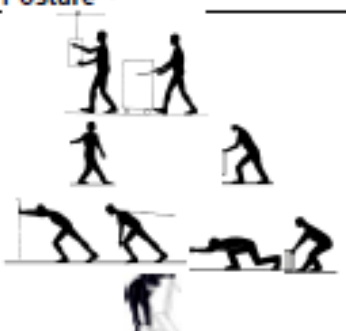
### 2nd step: Determination of rating points of mass, positioning accuracy, speed, posture and working conditions

Mass to be moved (load weight)	Industrial truck, aid				
	Without, load is rolled	Barrow	Carriage, roller, trolleys without fixed rollers (only steerable rollers)	Rail cars, hand carts, roller tables, carriages with fixed rollers	Manipulators, rope balancers
<b>rolling</b>					
< 50 kg	0.5	0.5	0.5	0.5	0.5
50 to < 100 kg	1	1	1	1	1
100 to < 200 kg	1.5	2	2	1.5	2
200 to < 300 kg	2	4	3	2	4
300 to < 400 kg	3		4	3	
400 to < 600 kg	4		5	4	
600 to < 1000 kg	5			5	
≥ 1000 kg					
<b>sliding</b>			<p><b>Grey areas:</b> Critical because a check of the movement of industrial truck/load depends very much on skill and physical strength.</p> <p><b>White areas without number:</b> Basically to be avoided because the necessary action forces can easily exceed the maximum physical forces.</p>		
< 10 kg		1			
10 to < 25 kg		2			
25 to < 50 kg		4			
> 50 kg					

Positioning accuracy	Speed of motion	
	slow (< 0.8 m/s)	fast (0.8 bis 1.3 m/s)
Low - no specification of travelling distance - load can roll to a stop or runs against a stop	1	2
High - load must be accurately positioned and stopped - travelling distance must be adhered to exactly - frequent changes in direction	2	4

*Note: the average walking speed is approx. 1 m/s*

In general the whole muscular-skeletal system is subject to strain when pushing and pulling, but in particular the hand-arm-shoulder area. Depending on the specific force applications and postures, however, it is also possible that the lumbar spine and the hip and knee joints will be under severe strain. Because the physical forces are substantially lower and more varied than when lifting and carrying, it is difficult to verify chronic damage from overload. It is typical for pulling and pushing that there is a risk to the muscular-skeletal system from sudden overload as a result of impact, slipping or unexpected and great forces with change of direction or when stopping.

Posture <sup>1)</sup>		
	Trunk upright, not twisted	1
	Trunk slightly bending forward or slightly twisted (one-sided pulling)	2
	Body inclined low in direction of motion Squatting, kneeling, bending	4
	Combination of bending and twisting	8

1) The typical posture must be used. The greater trunk inclination possible when starting up, braking or shunting can be ignored if it only occurs occasionally.

Working conditions	
Good: → floor or other surfaces level, firm, smooth, dry → no incline → no obstacles in work-space → rollers or wheels run easily, no evident wear in the wheel bearings	0
Restricted: → floor soiled, a little uneven, soft → slight incline up to 2° → obstacles in work-space which have to be bypassed → rollers or wheels soiled, no longer run easily, bearings worn	2
Difficult: → unpaved or roughly paved roadway, potholes, severe soiling → inclines of 2° to 5° → Industrial trucks have to be torn loose when starting up → rollers or wheels soiled, bearings run sluggishly	4
Complicated: → steps, stairs → inclines >5° → combinations of indicators from "restricted" to "difficult"	8

Indicators not mentioned in the table must be added as appropriate.

### 3<sup>rd</sup> step: Evaluation

The rating points relevant to this activity are to be entered and calculated in the diagram.

+	Mass/Industrial truck	X	Time rating points	X	for women employees: 1.3	=	Risk score
	Positioning accuracy/ speed of motion						
	Posture rating points						
	Working conditions rating points						
=	Total						

On the basis of the rating points calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>2)</sup>	Risk score	Description
1	< 10	Low load situation, physical overload unlikely to appear.
2	10 to < 25	Increased load situation, physical overload is possible for less resilient persons <sup>3)</sup> . For that group redesign of workplace is helpful.
3	25 to < 50	Highly increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace is recommended.
4	≥ 50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

2) The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.

3) Less resilient persons in this context are persons older than 40 or younger than 21 years, newcomers in the job or people suffering from illness.

ANNEX 5 – CALCULATION SHEET OF REBA

FOLHA DE CÁLCULO REBA

GRUPO A: Tronco, pescoço e pernas

Tronco			
Movimento	Pontuação	Mudar Pont.	
Ereto	1		
0°-20° flexão	2		
0°-20° extensão	2		
20°-60° flexão	3	+1 se na torção ou flexão lateral	
>20° extensão	3		
> 60° flexão	4		
Pescoço			
Movimento	Pontuação	Mudar Pont.	
0°-20° flexão	1	+1 se na torção ou flexão lateral	
>20° flexão ou extensão	2		
Pernas			
Movimento	Pontuação	Mudar Pont.	
Peso bilateral andando ou sentado	1	+1 se joelhos entre 30° e 60° flexão	
Peso unilateral ou postura instável	2	+2 se joelhos > 60° flexão	
Carga/Força			
0	1	2	+1
< 5 Kg	5 a 10 Kg	> 10 Kg	Choque ou rápido desencadeamento da força

PONTUAÇÃO A

QUADRO A									
Pernas		Tronco							
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

QUADRO B									
Pulso		Braço							
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

QUADRO C									
Pontuação B									
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

- Uma ou mais partes do corpo estéticas + 1 min.
- Ações repetidas mais de 4x por minuto
- A acção causa rápidas alterações à postura ou uma base instável

PONTUAÇÃO B

PONTUAÇÃO FINAL (REBA):

GRUPO B: Braços, antebraços e pulsos			
Braços			
Movimento	Pontuação	Mudar Pont.	
0°-20° flexão/ extensão	1	+1 se na abdução ou rotação	
>20° extensão ou 20°-45° flexão	2	+1 se na elevação do ombro	
45°-90° flexão	3	-1 se apoiado suportando o peso. Acção da gravidade.	
>90° flexão	4		

Movimento	Score	
60°-100° flexão	1	
<60° flexão ou >100° flexão	2	

Movimento	Pontuação	Mudar Pont.	
0°-15° flexão/ extensão	1	+1 se na desvio lateral ou torção	
>15° flexão/ extensão	2		

Pontuação Quadro B			
Ligação - Coupling			
0	1	2	3
Pega bem ajustada, mas não ideal	Pega não ajustada, sem insegurança, sem pega de aceleração por outra parte do corpo	Pega não ajustada, sem insegurança, sem pega de aceleração por outra parte do corpo	Pega difícil e insegura, sem pega de aceleração por outra parte do corpo

## ANNEX 6 – REBA CALCULATION FOR EACH ACTIVITY

Activity	Sub activity	Group A			L	S A	Grupo B			G	S B	C	REBA		
		Trunk	Neck	Leg	Load	Score A	Arm	Forearm	Wrist	Grip	Score B	Correction	REBA Score	Action level	Risk Level
Cooking	Prepares	2	2	1	0	3	3	2	2	1	5	2	7	2	Medium
	oven	5	3	2	0	8	3	2	1	0	4	1	10	3	High
	Cooker	3	2	1	0	4	4	2	3	1	8	1	9	3	High
	Grill	2	2	1	0	3	4	2	3	0	7	2	9	3	High
	Soup	2	2	1	2	5	4	2	3	1	7	1	8	3	High
													9		

Activity	Sub activity	Group A			L	S A	Grupo B			G	S B	C	REBA		
		Trunk	Neck	Leg	Load	Score A	Arm	Forearm	Wrist	Grip	Score B	Correction	REBA Score	Action level	Risk Level
Washing dishes	Take trays upper level	1	2	1	0	1	5	2	2	1	9	1	7	2	Medium
	Take trays medium level	1	2	1	0	1	4	1	2	1	6	1	4	2	Medium
	Take trays low level	4	2	4	0	8	2	2	2	1	4	1	10	3	High
	Remove leftovers	3	2	1	0	4	4	2	2	1	7	1	8	3	High
	Organise in dishwasher	3	2	1	0	4	3	2	2	0	5	2	7	2	Medium
	Take clean dishes	3	3	1	0	5	3	2	3	1	6	1	7	2	Medium
													7		

Activity	Sub activity	Group A			L	S A	Grupo B			G	S B	C	REBA		
		Trunk	Neck	Leg	Load	Score A	Arm	Forearm	Wrist	Grip	Score B	Correction	REBA Score	Action level	Risk Level
washing pots	remove leftovers	5	3	2	2	10	4	2	3	1	8	1	12	4	Very high
	washing up	3	3	1	2	7	4	2	3	1	7	1	10	3	High
													11		

Activity	Sub activity	Group A			L	S A	Grupo B			G	S B	C	REBA		
		Trunk	Neck	Leg	Load	Score A	Arm	Forearm	Wrist	Grip	Score B	Correction	REBA Score	Action level	Risk Level
Cleaning	Peel area	3	3	3	0	7	4	2	3	1	8	1	11	4	Very High
	kitchen table	4	3	3	0	8	4	2	3	1	8	1	11	4	Very High
	Floors	3	3	2	0	6	3	2	1	1	5	1	9	3	High
													10		

## **ANNEX 7 – KIM CALCULATIONS FOR ACT LIFTING / LOWERING / HOLD /CARRY ACTIVITIES**

### **Activity 1: Organize the fridge.**

Load score (4) + posture score and load position (4) + score of working conditions (1) = (9)

Total (9) \* time score (4) = (36) total risk score

### **Activity 2: carry chopped vegetables.**

Load score (4) + posture score and load position (2) + score of working conditions (1) = (7)

Total (7) \* time score (2) = (14) total risk score

### **Activity 3: handling potatoes and carrots in peel área**

Load score (4) + posture score and load position (4) + score of working conditions (1) = (9)

Total (9) \* time score (2) = (18) total risk score

## **ANNEX 8 – KIM CALCULATIONS FOR PUSH / PULL ACTIVITIES**

### **Activity 4: carry meats from fridge to counter**

score of speed and accuracy movement (2) + load score (2) + posture score (4)  
+ score of working conditions (8) = 16

Total (16) \* time score (1) = (16) total risk score

### **Activity 5: carry vegetables from fridge to chop area**

score of speed and accuracy movement (2) + load score (1) + posture score (4)  
+ score of working conditions (8) = 15

Total (15) \* time score (2) = (30) total risk score

### **Activity 6: carry food already cooked**

score of speed and accuracy movement (2) + load score (1) + posture score (2)  
+ score of working conditions (2) = 7

Total (7) \* time score (2) = (14) total risk score